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Philosophy of Science

Between the Natural Sciences, the Social Sciences, and the Humanities
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Introduction

This volume contains a selection of papers delivered at the Second International Conference of the German Society for Philosophy of Science (Gesellschaft für Wissenschaftsphilosophie, GWP) which took place at the Heinrich Heine University in Düsseldorf, Germany, from March 8 to 11, 2016, and was hosted by the Düsseldorf Center for Logic and Philosophy of Science (DCLPS). GWP.2016 was sponsored by the Heinrich Heine University Düsseldorf and the Düsseldorf Center for Logic and Philosophy of Science, the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG), and the Journal for General Philosophy of Science (Springer). The GWP organizers were Holger Lyre (Magdeburg), Ulrich Krohs (Münster), Thomas Reydon (Hanover), and Uljana Feest (Hanover). The Local Organization Committee consisted of Gerhard Schurz (chair), Alexander Christian, Christian J. Feldbacher-Escamilla, Alexander Gebharter, David Hommen, Nina Retzlaff, and Paul Thorn.

The aim of GWP.2016 was to enable philosophers of science from Germany and other countries to meet and engage in fruitful discussions on current research topics in philosophy of science and to strengthen the international philosophy of science community. It was also intended to bring together philosophers of science working in different fields of philosophy of science; accordingly, the organizers decided to entitle GWP.2016 “Philosophy of Science: Between the Natural Sciences, the Social Sciences, and the Humanities.” Since GWP.2016 comprised a number of outstanding contributions, the organizers decided to publish this volume, which is included in the Springer book series of the European Philosophy of Science Association, besides a special issue of the Journal for General Philosophy of Science (JGPS) devoted to GWP.2016.

GWP.2016 had more than 150 participants (approx. one-third were women and about one-fifth were students or graduate students), who came from 16 European and 6 non-European countries. There were 6 plenary lectures given by invited speakers, 62 contributed papers, and 7 contributed symposia (with 19 symposia talks). All in all, GWP.2016 featured 87 talks. The plenary lectures were given by Rainer Hegselmann (Bayreuth), Paul Hoyningen-Huene (Hanover), Michela Massimi (Edinburgh), Stathis Psillos (Athens), Alexander Rosenberg (Duke), and
Gila Sher (San Diego). The conference featured contributed papers and symposia covering all subfields of philosophy of science. The main sections were general philosophy of science (approx. 30%), philosophy of life sciences (approx. 20%), philosophy of natural sciences (approx. 15%), and philosophy of social sciences and humanities (approx. 10%). There were also sections on other fields of philosophy of science and also on more specific topics (all in all approx. 25%). In particular, these were causality, confirmation, history of philosophy of science, mechanisms, philosophy of mathematics, and values in science. The seven symposia dealt with absences in biological and medical explanations, constitution, genetics and culture, philosophy of science and engineering, and quantum gravity.¹

The list of authors who agreed to contribute to this collection includes renowned experts from several fields in philosophy of science who contributed talks to GWP.2016, including one invited talk of GWP.2016, for which we are particularly thankful. Moreover, the collection presents research of young scientists and has a comparably high share of female authors (one-third).

The essays in this volume are divided into four parts: (1) philosophy of physics, (2) philosophy of life sciences, (3) philosophy of social sciences and values in science, and (4) philosophy of mathematics and formal modeling. We hope that the collection provide insights into a number of ongoing discussions in important subfields of philosophy of science and it will therefore be interesting for an interdisciplinary and multidisciplinary readership.

**Philosophy of physics**: This part includes papers on unification in high energy physics, cosmology, and causation in physics, including contributions about core arguments in favor of scientific realism, the unification of fundamental forces in physics, testability of multiverse theories, and causal determination in spacetime theories.

In his contribution, Paul Hoyningen-Huene addresses two famous arguments in favor of scientific realism. He first discusses a peculiarity of the realism-antirealism debate. Some authors defending antirealist positions in a philosophical discussion seem to be inconsistent with what they do when treating scientific subjects. In the latter situation, they behave as realists. Hoyningen-Huene argues that this tension can be dissolved by distinguishing different discourses belonging to different levels of philosophical radicality. Depending on the respective level, certain presuppositions are either granted or questioned. The author then turns to a discussion of the miracle argument by discussing a simple example of curve fitting. In the example, multiple use-novel predictions are possible without indicating the truth of the fitting curve. It is argued that because this situation has similarities with real scientific cases, it sheds serious doubt upon the miracle argument. Next, Hoyningen-Huene discusses the strategy of selective realism, especially its

additional crucial component, the continuity argument. The continuity of some X in a series of theories, with X being responsible for the theories’ use-novel predictions, is taken to be a reliable indicator for the reality of X. However, the continuity of X could as well be due to the similarity of the theories in the series with an empirically very successful theory embodying X, without X being real. Thus, the author concludes that the two main arguments for scientific realism show severe weaknesses.

**Kian Salimkhani**’s contribution deals with the central challenge of fundamental physics to develop a unified theory of quantum gravity (QG): the combination of general relativity and quantum mechanics. The common conviction is that the quest for QG is not only fueled but generated by *external* principles and hence driven, first and foremost, by reasoning involving philosophical assumptions. Against this, Salimkhani claims that it is exactly the particle physics stance – taken, e.g., by Weinberg and others – that reveals the issue of QG as a genuine physical problem arising within the framework of quantum field theory (QFT). Salimkhani argues that the quest for QG sets an important and often misconceived example of physics’ *internal* unificatory practice. Physics’ internal strategies – e.g., exploiting the explanatory capacities of an established theory – suffice to explain the search for a theory of quantum gravity. To set the stage for his argument, the author recaps what the research program of QG is about and what remarks suspecting a “dogma of unification” amount to. Subsequently, two important consequences for our understanding of general relativity (GR) and the issue of QG are briefly discussed: First, it is suggested that we should not take GR as a fundamental theory because it can be reduced to QFT. Second, the investigation serves as a clarification of what the problem with QG actually is. Afterward, some objections against the advocated picture are mentioned and very briefly replied to, before the author revisits the opening question concerning the alleged “dogma of unification.”

**Keizo Matsubara** discusses predictions and explanations in multiverse scenarios. Many researchers in contemporary physics take the possibility that our universe is just one of many in a multiverse seriously. In the current debate, however, speculations about multiverses are often connected to arguments using the controversial anthropic principle, which many critics find to be untestable and unscientific. In his contribution, Matsubara suggests criteria that need to be satisfied before a multiverse theory should be considered scientifically respectable. While presently proposed multiverse scenarios do not yet live up to criteria strong enough to be counted as part of well-established science, the author argues that one could in principle find good scientific reasons for accepting a theory entailing that we live in a multiverse. Multiverse theories, if sufficiently developed, can have testable predictions. Accordingly, Matsubara is interested in the question how we in principle can test *specific* multiverse theories, as opposed to evaluating the generic idea that we live in a multiverse. For this, Matsubara focuses on string theory and its multiple stable solutions, which for Matsubara represent a landscape of possible multiverses. In some cases, a multiverse theory can be testable; however, to properly test a multiverse theory, it is important to distinguish new predictions from explanations based on the multiverse.
Andrea Reichenberger devotes her contribution to the work of mathematician and physician Luise Lange (1891–1978). In her articles on the clock paradox and the relativity of time, Lange defends the theory of relativity against philosophical refutations. The clock paradox concerns the phenomenon of time dilation, which is a direct consequence of special relativity: if there are two synchronous clocks at the same inertial reference frame and one of them is moved along a closed curve with constant velocity until it has returned after some time to its point of departure, this clock will lag on its arrival behind the clock that has not been moved. This effect seems to be paradoxical because, in relativity, it appears that either clock could “regard” the other as the traveler, in which case each should find the other delayed – a logical contradiction. Lange shows, however, that the apparent clock paradox is not a paradox but merely conflicts with common sense and is based on a misunderstanding of the theory. Reichenberger’s study explores, contextualizes, and analyzes Lange’s clear and sophisticated contribution to the debate for the first time.

Philosophy of life sciences: This part begins with a contribution by Anne Sophie Meincke about recent developments in the philosophy of biology toward a biologically grounded concept of agency. Herein, agency is described as bio-agency: the intrinsically normative adaptive behavior of human and nonhuman organisms, arising from their biological autonomy. Meincke’s contribution assesses the bio-agency approach by examining criticism recently directed by its proponents against the project of embodied robotics. Defenders of the bio-agency approach have claimed that embodied robots do not, and for fundamental reasons cannot, qualify as artificial agents because they do not fully realize biological autonomy. More particularly, it has been claimed that embodied robots fail to be agents because agency essentially requires metabolism. Meincke argues that this criticism, while being valuable in bringing to the fore important differences between bio-agents and existing embodied robots, nevertheless is too strong. It relies on inferences from agency-as-we-know-it to agency-as-it-could-be which are justified neither empirically nor conceptually.

Roger Deulofeu and Javier Suárez focus on their contribution on the common appeal to mechanistic explanations in contemporary philosophy of science. Mechanists argue that an explanation of a phenomenon consists of citing the mechanism that brings the phenomenon about. In their contribution, the authors present an argument that challenges the universality of mechanistic explanation: in explanations of the contemporary features of the eukaryotic cell, biologists appeal to its symbiogenetic origin. Therefore, the notion of symbiogenesis plays the main explanatory role. Deulofeu and Suárez defend the notion that symbiogenesis is non-mechanistic in nature and that any attempt to explain some of the contemporary features of the eukaryotic cell mechanistically turns out to be at least insufficient and sometimes fails to address the question that is asked. Finally, the authors suggest that symbiogenesis is better understood as a pragmatic scientific law and present an alternative non-mechanistic model of scientific explanation. In the model they present, the use of scientific laws is supposed to be a minimal requirement of all scientific explanations, since the purpose of a scientific explanation is to make
phenomena expectable. Therefore, this model would help to understand biologists’ appeal to the notion of symbiosis and thus is shown to be better, for the case under examination, than the mechanistic alternative.

**Ludger Jansen**’s contribution is concerned with functional explanations, which interestingly apply not only in cases of normal functioning but also in the case of malfunctioning. According to a straightforward analysis, a bearer of the function to F is malfunctioning if and only if it does not F although it should do so. This makes malfunctions and malfunctionings analogous to negative causation and thus problematic, because they seem to involve absent dispositions and absent processes. This analysis seems also to require that the function to F cannot be identical with the disposition to F. Thus, we seem to be trapped in a dilemma: If the realm of functions is separated from the realm of dispositions, then it seems that functions cannot be causally efficacious. Alternatively, functions are considered to be identical with dispositions, but then malfunctioning seems to be conceptually impossible.

Jansen’s contribution defends and further develops the thesis of Röhl and Jansen that functions are not a special type of dispositions. For this purpose, it first reviews different varieties of malfunction and malfunctioning and suggests definitions of both malfunction and malfunctioning. The author discusses the special-disposition account of the basic formal ontology (BFO), which Spear et al. have defended by suggesting various strategies on how a special-disposition account can deal with malfunctions. On the one hand, Jansen’s contribution evaluates these strategies and indicates several problems arising from them. On the other hand, it describes how to account for the non-optionality and the causal efficacy of functions, if functions are not dispositions. While function types are not identical to disposition types, there are important interrelations between functions and dispositions, namely, (1) heuristically, (2) from a design perspective for artifact functions, and (3) from an evolutionary perspective for types of biological functions.

**Peter Hucklenbroich**’s contribution deals with disease entities and the naturalness of disease classifications in medical pathology. In the twentieth- and twenty-first-century medicine, the concept of a disease entity has proven to be of key importance for pathology and the theory of diseases. Disease entities are kinds of complex clinical and etiopathogenetic processes that are triggered by specific primary causes and develop on anatomical, physiological, clinical, and subjectively experienced levels. They are distinguished from healthy states of life by definite criteria of pathologicity. Hucklenbroich sketches the prehistory as well as the central features of the current paradigm of disease entities. Since the 1970s, philosophical theories of disease tend to ignore or, at best, reject this concept. By examining the well-respected theories of H. Tristram Engelhardt, Jr., and Caroline Whitbeck, it is shown that this defensive attitude results from a philosophical misconception of the concept. Engelhardt criticizes the concept of disease entity because he erroneously assumes, as Hucklenbroich argues, that explanations using this concept are inconsistent with explanations by laws of physiology. On the other hand, Whitbeck correctly refers to the modern, scientific version of the concept. But in her opinion, the concept “cause of disease” is defined according to certain “instrumental interests” that may differ between subjects and is, thus, neither objec-
tive nor unique and unequivocal. Hence, the concept of disease entity is ambiguous and not suited for establishing a unique, unambiguous, and unequivocal natural classification of diseases. Hucklenbroich shows that Whitbeck’s objections rest upon misconceptions concerning the concept of “primary cause,” i.e., “etiological factor,” and of the so-called “multi-factorial” causation. By reference to a careful, medically and philosophically correct reconstruction of these concepts, he aims to show that her objections do not apply.

**Philosophy of social sciences and values in science:** This part starts with a contribution by Martin Carrier who addresses matters of agnotology, a research field decisively influenced by Robert Proctor, who introduced the notion in 1992. Agnotology refers to the active creation and preservation of confusion and ignorance. Focusing on his contribution to the intentional production of misleading information or the deliberate creation of epistemically detrimental dissent, however, Carrier recognizes several nontrivial epistemological problems requiring clarification. First, the purpose of generating confusion is typically difficult to ascertain. Accordingly, identifying a publicly accessible mistake would be helpful for pinpointing agnotological ploys. Second, the idea underlying Proctor’s notion is that sociopolitical motives have trumped or outplayed the quest for knowledge. However, implementing this idea demands the distinction between epistemic and non-epistemic values. The former appreciate knowledge and understanding, while the latter refer to sociopolitical interests and utility. Many philosophers of science do not acknowledge an in-principle distinction between the two. At the same time, they are committed to scientific pluralism. Both considerations come together in raising the problem which methodological standards are violated in the production and maintenance of ignorance. Carrier proposes to identify agnotological ploys by the discrepancy between the conclusions suggested by the design of a study and the conclusions actually drawn or indicated. This mechanism of “false advertising” serves to implement agnotological ploys and helps to identify them without having to invoke the intentions of the relevant agents. The author discusses three agnotological cases, i.e., studies on bisphenol A, Bt-maize/Roundup, and Gardermoen’s airport in Oslo. Pinpointing agnotological endeavors is a means for weeding out approaches that look fitting at first glance but which are, in fact, blatantly inappropriate. Identifying such endeavors serves to reduce the range of studies under consideration and thus helps to manage pluralist diversity.

Elizaveta Kostrova investigates in her contribution the “ought” dimension in value theory and John Dewey’s notion of the desirable from a philosophical as well as a sociological standpoint. The concept of “value” is widely used in various fields, and it has recently become the subject of empirical research. However, there is no common understanding of what it is. From the very start, the scope of value has been part of the opposition of what “is” to what “ought to be,” and the fact that value judgments contained a normative element seemed to make the exclusion of value from the area of scientific analysis inevitable. As Kostrova shows in her contribution, John Dewey offers a different way of reasoning about values, which would allow scientists to keep the normativity in a way of saving the specificity of the concept. In order to do this, Dewey links the source of value with
the evaluation process and introduces the concept of the “desirable” drawing the line between the “desirable” and the “desired.” Clyde Kluckhohn later borrowed this concept from Dewey while formulating the concept of values within Parsons’ theory of action. Thanks to him, the “desirable” has become a favorite part of value definition among different researchers. As a result of this development, the concept of “desirability” has been transformed: for example, in social psychology, the “desirable” has moved closer to the “important,” and the significance of the normative aspect has diminished, evolving to a more descriptive understanding, while the social dimension, though present already in Dewey, has greatly increased. Kostrova’s contribution considers the appearance of Dewey’s notion of the desirable in the definition of value as well as its role in it and its further application in the study of values.

Lara Huber analyzes how standards shape scientific knowledge. Standards are said to provide trust in scientific methodology in general and measuring devices in particular. To standardize means to formalize and regulate scientific practices and to prioritize instrumental and methodological prerequisites of research: Standardization impacts on the design of experiments concern the reporting of outcomes and the assessment of research (e.g., peer review process). Studies in the history of science and technology have shown that standards contribute significantly to the evolution and validation of scientific practices. The philosophy of science is as yet only beginning to analyze systematic challenges posed by standardization. The main interest of Huber’s contribution is to elaborate on the question how standards relate to ends that facilitate and/or allow for knowledge claims in experimental sciences in general. The author intends to inform about scientific practices in different fields of research that address given ends of standardization. First of all, Huber presents three examples of standards in science. Her contribution then focuses on three ends purported to serve epistemic needs in different fields of scientific inquiry: stability, homogeneity, and internal validity. She presents three case studies on standardization in different fields of scientific research, ranging from physics and measurement science to population-based trial design in psychology and medicine, in order to inquire into the reality of standards as being very specific tools with defined uses while sharing general suppositions about which ends they serve within the realm of science.

Philosophy of mathematics and formal modeling: This part starts with a contribution by Jens Harbecke who addresses a potential problem for his offered methodology of constitutive inference in the context of mechanistic explanation. According to the mechanistic approach, an adequate explanation demands an analysis of the mechanisms “underlying” an explanandum phenomenon at several levels. A central challenge for this approach consists in offering an account of how such mechanistic explanations can be established. As many authors have observed, the relationship between phenomena and their mechanisms cannot be a causal one, because a causal relationship is commonly considered to hold only between non-overlapping events, but a mechanism is believed to overlap with the phenomenon in space and time. Their noncausal and synchronous relation is usually referred to as “constitution.” The problem seems to be that even when all causal relationships
among mechanisms or parts of mechanism have been identified, it remains unclear whether all constitutive relationships among mechanisms and phenomena have been established thereby as well. Against this, Harbecke argues that it is possible to explicate a methodology for the establishment of constitutive explanations, although the latter differs substantially from methodologies establishing causal relationships. Harbecke’s so-called methodology of constitutive inference is ultimately based on Mill’s “method of difference,” which requires a complete variation of factors in a given frame. In constitutive contexts, however, such a complete variation is often impossible. The author offers a solution to this problem that utilizes the notion of a “mechanism slice.” In a first step, an example of a currently accepted explanation in neuroscience is reconstructed, which serves as a reference point of the subsequent discussion. It is argued that the proposed solution accommodates well all schematic situations in which the impossibility of varying all test factors could be expected either to lead to false inferences or to preclude the establishment of correct constitutive claims.

**Antonio Piccolomini d’Aragona** considers Dag Prawitz’s recent theory of grounds. Since the 1970s, Prawitz has been interested in general proof theory. His normalization theorems play in natural deduction systems the role that Gentzen’s cut-elimination plays in sequent calculi, a syntactic result which is extended to semantics through what Schroeder-Heister calls the “fundamental corollary of normalization theory,” stating that every closed derivation in intuitionistic logic can be reduced to one using an introduction rule in its last step. The framework is inspired by Gentzen’s notion that the introduction rules represent the definitions of the symbols concerned, and the elimination rules are no more than the consequences of these definitions. According to Prawitz, however, this is not the only possible approach to general proof theory, since one could also try to give a direct characterization of different kinds of proofs. From this standpoint, the influence of Gentzen and Dummett is accompanied by references to the Brouwer-Heyting-Kolmogorov (BHK) clauses. Already in 1977, Prawitz addressed the non-decidable character of the BHK proofs. In his more recent papers, Prawitz provides indications on how the ground-theoretic framework should be developed. However, the overall project still seems to be in an embryonic stage. In his contribution, Piccolomini d’Aragona addresses a threefold task. First, he analyzes the decidability problem within the BHK approach. Next, the author proposes a partial calculus for Prawitz’s theory of grounds. After introducing a core calculus for Gentzen’s introductions, he defines two expansions of it, one for full first-order minimal logic and another for a kind of “metalanguage” of grounds. These expansions help understand the final task, a ground-theoretic reformulation of the BHK decidability issue.

The final contribution by **Axel Gelfert** analyzes the concept and relevance of exploration in the context of scientific modeling. Traditional frameworks for evaluating scientific models have tended to downplay their exploratory function; instead they emphasize how models are inherently intended for specific phenomena and are to be judged by their ability to predict, reproduce, or explain empirical observations. By contrast, Gelfert argues that exploration should stand alongside explanation, prediction, and representation as a core function of scientific models.
Thus, models often serve as starting points for future inquiry, as proofs of principle, as sources of potential explanations, and as a tool for reassessing the suitability of the target system (and sometimes of whole research agendas). This is illustrated by a case study of the varied career of reaction-diffusion models in the study of biological pattern formation, which was initiated by Alan Turing in a classic 1952 paper. Initially regarded as mathematically elegant, but biologically irrelevant, demonstrations of how, in principle, spontaneous pattern formation could occur in an organism, such Turing models have only recently rebounded, thanks to advances in experimental techniques and computational methods. The long-delayed vindication of Turing’s initial model, the author argues, is best explained by recognizing it as an exploratory tool (rather than as a purported representation of an actual target system).

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